BUROHAPPOLD ENGINEERING

# Northumberland Development Project

## Water Strategy

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7 September 2015

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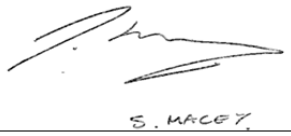
| signature |  |
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# Contents


**1 Executive Summary** **7**

1.1 Water Resources 7

1.2 Drainage 7

1.3 Flood Risk 8

1.4 Consultation 8

**2 Introduction** **9**

2.1 Development Description 9

2.2 Purpose of this Water Strategy 11

2.3 Assumptions 13

**3 Policies Affecting Water** **15**

3.1 Water Demand and Usage 15

3.1.2 The European Union Water Framework Directive 16

3.1.3 The Water Act 2014 16

3.1.4 The Mayor's Water Strategy, October 2011 17

3.1.5 Supplementary Planning Guidance on Sustainable Design and Construction 17

3.1.6 Targets and Standards 17

3.2 Water Supply 18

3.3 Drainage & Flooding 19

**4 Water Demand** **22**

4.1 Baseline Demand 22

4.1.1 Introduction 22

4.1.2 Average Peak Day Demand Baseline 22

4.1.3 Annual Baseline 25

**5 Meeting demand** **27**

5.1 Introduction 27

5.2 Demand Reduction Measures 27

5.2.1 Introduction 27



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5.2.2 Demand Reduction - Social 27
5.2.3 Demand Reduction - Engineered 28
5.3 Matching Quality of Supply to Quality of Need 29
5.3.1 Potable water 29
5.3.2 Rain water 29
5.3.3 Ground water 30
5.3.4 Greywater recycling 30
5.3.5 Black water 30
5.3.6 Water Supply Summary 30
**6 Water demand strategy 31**
6.1 Demand reduction targets 31
6.2 Incentives 31
6.3 Efficiency Demand Reduction 31
6.4 Non Potable Sources 32
6.4.1 Stadium including Tottenham Experience. 33
6.4.2 Residential 33
6.4.3 Extreme Sports 33
6.4.4 NE Podium Building 33
6.5 Demand Reduction Conclusions 33
**7 Drainage strategy 34**
7.1 Objectives 34
7.1.1 Methodology 34
7.2 Background 34
7.2.1 Existing Surface Water Runoff Drainage Summary 34
7.2.2 Existing Foul Drainage Summary 35
7.2.3 Existing Ground Conditions 35
7.2.4 Existing Sustainable Drainage Systems 35
7.2.5 Exceedance 36


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7.3 Post Development Drainage Strategy 36

7.3.1 Surface Water Drainage Strategy 36

7.3.2 Foul Water Drainage Strategy 39

7.3.3 Pumping Stations 40

**8 Summary & Conclusions 42**

8.1 Summary 42

8.2 Conclusion 43

**Appendix A Water quality**


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# Glossary

| Term | Definition |
|---|---|
| BRE | Building Research Establishment Ltd. |
| BREEAM | BRE Environmental Assessment Method |
| CAMS | Catchment Area Management Plans |
| CIRIA | Construction Industry Research and Information Association |
| DEFRA | Department for Environment Food and Rural Affairs |
| DMR | Demand Reduction Measures |
| EA | Environment Agency |
| ECA | Enhanced Capital Allowances |
| FIFA | Fédération Internationale de Football Association (*International Federation of Association Football*) |
| FRA | Flood Risk Assessment |
| GLA | Greater London Authority |
| OFWAT | The Water Services Regulation Authority. |
| PPS25 | Planning Policy Statement 25: Development and Flood Risk |
| SUDS | Sustainable Drainage Systems |
| GA | General Admission |
| TWUL | Thames Water Utilities Limited |


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# 1 Executive Summary

The proposed Northumberland Development Project is centred on the redevelopment of Tottenham Hotspur Football Club stadium. In addition to the new 61,000 capacity stadium a 2000 $m^2$ Health/Office use building is proposed, along with a 4900m2 Tottenham Experience, 2100$m^2$ Extreme Sports Building, a 180 bedroom hotel with 49 Serviced Apartments and 579 residential properties with 4 towers of varying heights.

This Water Strategy describes the approach to all aspects of water use and management across the proposed Northumberland Development Project. The strategies described are the water supply and demand strategy and the foul and surface water drainage strategies.

## 1.1 Water Resources

The demand strategy is focused around the implementation of efficient water use practices across the development, including both social and engineered demand reduction measures. There are currently no defined water use targets for commercial properties but the demand reduction measures identified would provide significant reductions in water demand. Residential properties were assessed in accordance with the updated London Plan. A reduction in water demand from residential properties of 150 l/person/day to 105 l/person/day target has been demonstrated to be achievable. It is proposed to achieve the target rate within the residential area and significantly reduce the demand throughout the rest of the development by installing a combination of water efficient fittings such as:

- Low Flush, 4/2.6 l/flush, WCs throughout
- Water Efficient, 3.2 l/min, aerating taps throughout
- Water efficient, 9 l/min, showers within the residential and hotel developments.
- Water efficient, 80 l/use (150 l sized), baths where fitted
- Waterless urinals where fitted in Stadium, General Admission Concourse areas.
- Water efficient, 39 l/use, washing machine where fitted
- Water efficient, 10 l/use, dishwasher where fitted

## 1.2 Drainage

The site currently drains to separate surface water and foul sewers. The development will maintain the separation and connect into these networks. Local network upgrades will be made on Worcester Avenue with the addition of a new sewer. This is important in terms of managing the impact of the increase in discharge as a result of the increase in stadium capacity. The installation of water efficient fittings will further minimise the increase in discharge volume.

The surface water drainage of the site will aim to improve the existing situation through the introduction of SUDS across the site. This will provide attenuation of storm water to reduce the flood risk to the downstream catchments as well as to the development itself.

As a result of this approach the site-wide surface water discharge will be reduced from the current rate of 284l/ha/s to 150 l/ha/s. The surface water drainage strategy has been approved in principle by the EA , TWUL and Haringey Council.


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The foul drainage of the development will connect into the existing network and upgrades will be provided to ensure that the systems do not back up and avoid exceeding existing network capacity. The Stadium will drain into the High Road sewer to the west, the hotel and residential development to the south to Park Lane. The foul water drainage strategy will require a pumped system and has been approved in principle by TWUL.

### 1.3 Flood Risk

The site is located in EA Flood Zone 1, which means that the probability of fluvial and tidal flooding in any one year is less than or equal to 0.1%. Planning Policy Statement 25 (PPS25) requires that developments in Flood Zone 1 do not increase flood risk to the development or elsewhere through the addition of hard surfaces and increase in surface water run-off.

The provision of surface water attenuation will significantly reduce the risk of surface water flooding for the site. A controlled discharge rate from the underground storage tanks will also reduce the risk of the development surcharging the surface water drainage network and impacting on third parties.

A revised Flood Risk Assessment (FRA) has been written by Aecom and is provided as a separate document.

### 1.4 Consultation

Extensive consultation, has taken place between the design team and the Environment Agency (EA). The EA are aware of the development proposals and have confirmed informally their approval of the proposals. They acknowledge that the reduction of the surface water run-off rate from 284l/s/ha to 150l/s/ha represents a significant improvement and welcome the reductions in water usage that have been demonstrated against the baseline demands.

Agreement has also been reached with Thames Water Utilities Limited with regard to the site-wide surface water runoff and foul discharge rates.


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# 2 Introduction

## 2.1 Development Description

The Northumberland Development Project is an 11 hectare site centred on the redevelopment of the Tottenham Hotspur Football Club (THFC) stadium, White Hart Lane, in Haringey in North East London. The existing site contains the stadium, a number of residential properties, shops and the Wingate Trading Estate to the north, as shown in **Error! Reference source not found.**.

**Figure 2-1 Site location plan**

The proposed development is for the relocation of the stadium to the north, to the centre of the site, with a large supermarket proposed for the north of the site and residential units and hotel in the south. The current Masterplan is shown in **Error! Reference source not found.** and Figure 2-2. This Masterplan, and an outline area schedule, forms the basis for the numbers generated in this Water Strategy. The type and use of the developments are outlined below and the assumed built areas are contained in Table 2—1.


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- Stadium – New 61000 seat stadium
- Retail – THFC Experience/Museum. 4900m$^2$
- Extreme Sports Building-2100m$^2$
- Residential – 579 residential units, a mixture of, 2, 3 and 4 bed apartments.
- Hotel - 180 bedroom  Hotel and 49 Serviced Apartments

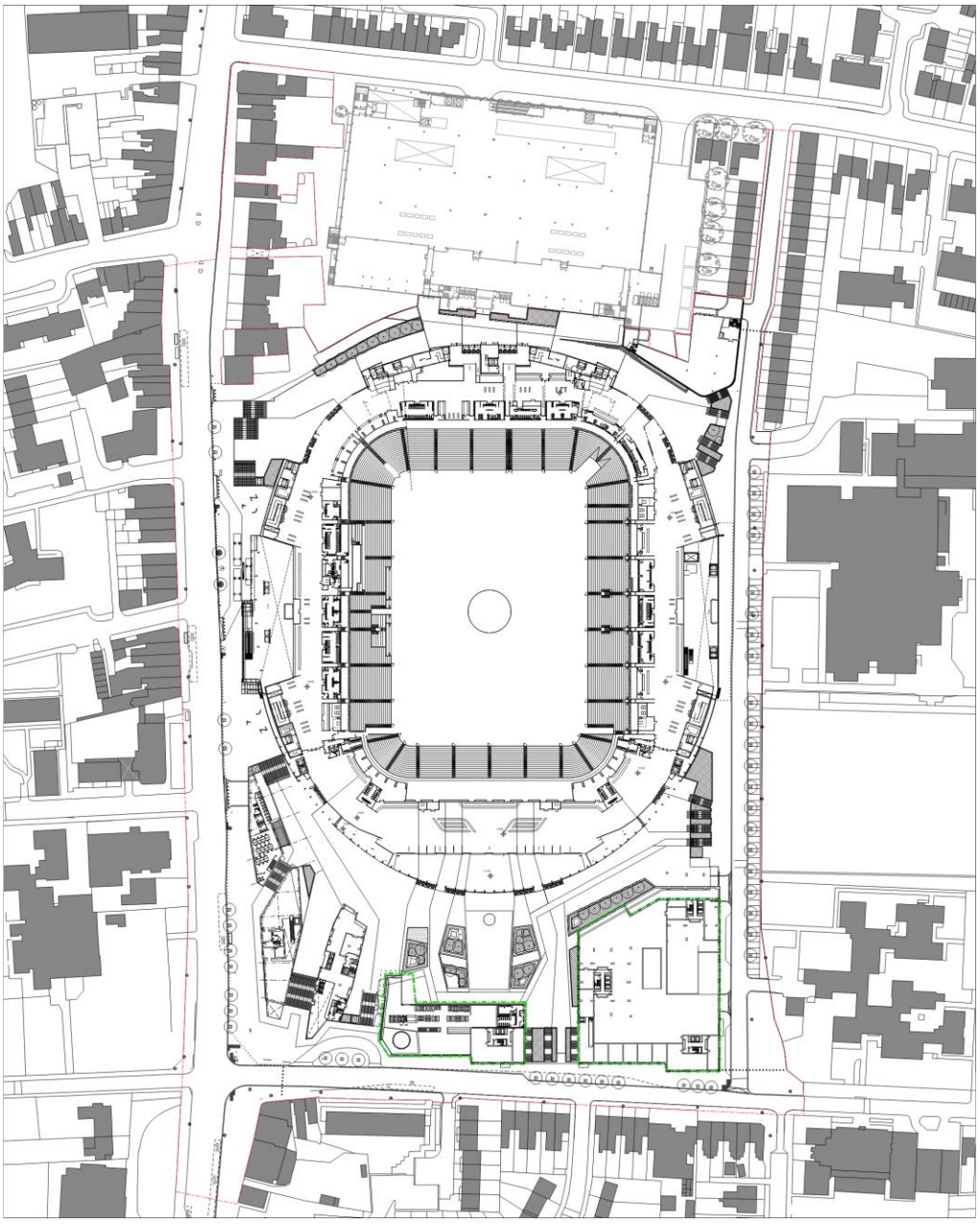

**Figure 2-2 Northumberland Development Masterplan**


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**Table 2—1 Assumed development size**

| Development | Assumed built area / occupancy |
|---|---|
| Stadium | 61,000 capacity |
| Tottenham Experience | 4,165m$^2$ |
| NE Building | 2000 m$^2$ |
| Hotel | 180 bedrooms plus 49 Serviced Apartments |
| Extreme Sports | 2100 m$^2$ |
| Residential | 579 units |

**Figure 2-3 NDP Masterplan**

## 2.2 Purpose of this Water Strategy

The proposals for the redeveloped White Hart Lane stadium and accompanying development will impact the water infrastructure in and around the local area. As well as the potential for increasing water demand from constructing a larger capacity stadium, the development will have new requirements for foul drainage and surface water flow management.

The purpose of a water strategy is to provide guidance to aid design development and to outline to the client how much investment needs to, and should be made in water based technologies. In recent years water strategies have also become important documents to accompany planning applications to demonstrate that consideration to protect and conserve water supplies and resources has been made from the first stages of a development. To this end this strategy will also ensure that sufficient information is given about water resource management and use to satisfy all stakeholders and will outline targets, where applicable, and strategies for each of the different aspects of water across the site.


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An overview of the Water Strategy processes is provided in the form of the flow diagram in Figure 2-4. This is an expanded water cycle diagram that charts the sources and movement of water through the water cycle and a development. All the processes shown need to be understood to ensure that the appropriate infrastructure is in place and that water is managed effectively ensuring efficient water use.

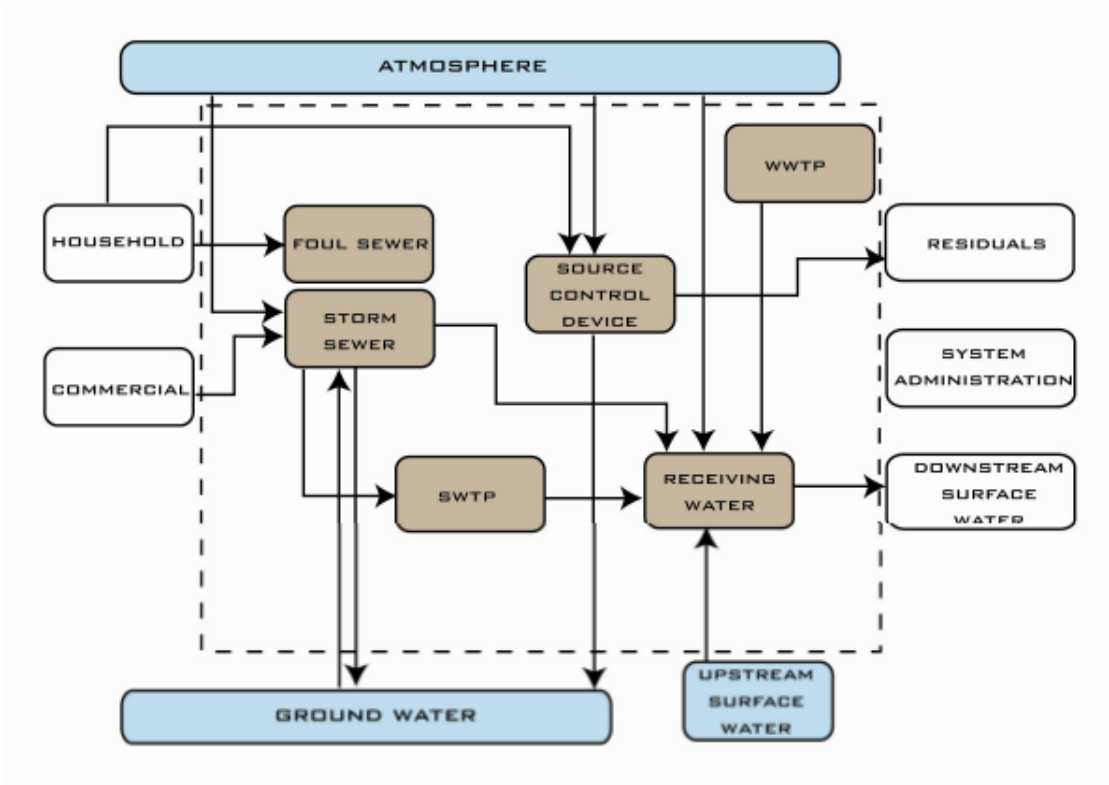


**Figure 2-4 Flow diagram**

This Water Strategy will take into account guidelines, standards and policy documents that affect the use of water. Where appropriate the objectives and targets defined within these documents are described together with how these targets will be met within the development. The documents referred to in this way are;

- The London Plan
- Local planning policies
- The Mayor's Water Strategy
- The European Water Framework Directive
- DEFRA –Future Water
- National Planning Policy Framework
- BREEAM
- Water Matters, Greater London Authority
- Key design standards


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- Part L Building Regulations
- CIRIA - Interim Code of Practice for Sustainable Drainage Systems

This Water Strategy is divided into the following sections.

| | |
|---|---|
| Section 3 - Policy | A description of the key policies that affect the Water Strategy |
| Section 4 – Water Demand | An explanation of the baseline requirements in terms of water demand |
| Section 5 – Meeting Demand | An assessment of how this demand can be met and a description of the demand reduction measures and water sources that could be employed in line with the policies outlined in Section 3 |
| Section 6 – Demand Strategy | Assessment of the which of the measures identified in Section 4 need to be used for this development and identification of the supply and demand strategy |
| Section 7 – Drainage | Description of surface water and foul drainage strategies |
| Section 8 - Summary & Conclusions | Summary of this Water Strategy. |

This strategy defines the high level concepts for dealing with water. It does not aim to provide detailed information as to how exactly the identified quantities of water will be delivered and removed from the site. These details will be provided over the course of the detailed design process in consultation with the key stakeholders, which will include Thames Water Utilities Limited (TWUL), the Environment Agency (EA), the London Borough of Haringey and others. As such it is the intention that this strategy provides sufficient detail to inform the stakeholders during the planning application process and acts as a basis for further discussions during the process of detailed design development post planning application.

## 2.3 Assumptions

This Water Strategy has been undertaken based on several key assumptions. Many of the assumptions relating to the individual aspects of the Strategy are discussed in the relevant sections. The key wider reaching assumptions are listed below;

Water Demands
- The demands are based on the latest area schedule, see Table 2—1.
- Baseline demands for the Stadium were calculated from usage information obtained from the Arsenal Emirates Stadium


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| | |
|---|---|
| | - The Megastore/Museum has been treated as if it were purely retail space |
| Meeting Demand | - The areas of roofs for estimating rainwater harvesting have been assumed based on the latest Masterplan. |
| | - This strategy does not assess the possible connection points to the potable main or the network; it identifies the total development demand. |
| Drainage | - The existing surface and foul networks are based on the plans provided by TWUL. |
| | - The strategy identifies possible connections to the existing networks but does not specify the development network or specific connection locations. |


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# 3 Policies Affecting Water

## 3.1 Water Demand and Usage

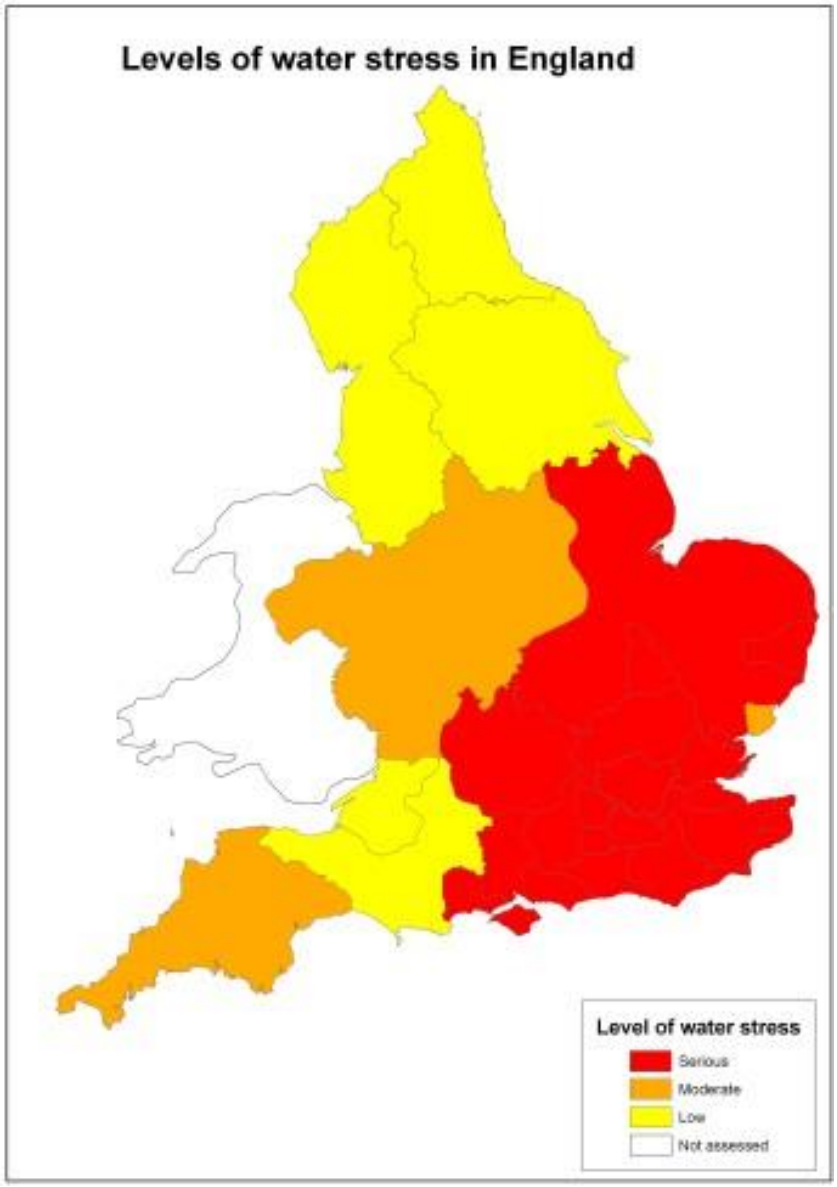


**Figure 3-1 Water stress in England and Wales (DEFRA image at ECA presentation, 12th March 2008)**

Demand for potable water is an issue that continues to gain momentum in the political and public arena. Areas of England are increasingly considered to be water stretched and hosepipe bans imposed by water authorities are becoming more frequent and longer in duration. The south-east and London experience relatively low rainfall, this combined with the rate of development and the burgeoning population continue to place significant strain on the water infrastructure. The current level of stress on water supplies in England and Wales is illustrated in Figure 3-1.


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The approach to water demand is introduced in Section 4. The approach supports various EU, UK and London strategies including:

**The European Water Framework Directive**

- Directive 2000/60/EC of the European Parliament (October 2000)
- http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF

**The Water Act, UK Parliament (May 2014)**

- http://www.legislation.gov.uk/ukpga/2014/21/contents/enacted

**Water Matters, Efficient Water Management in London, Greater London Authority (September 2012)**

- http://www.london.gov.uk/sites/default/files/Water%20management%20report%20pdf.pdf

**Securing London's Water Future – The Mayor's Water Strategy (October 2011)**

- https://www.london.gov.uk/sites/default/files/water-strategy-oct11.pdf

**Supplementary Planning Guidance on Sustainable Design and Construction Greater London Authority (April 2014)**

- https://www.london.gov.uk/sites/default/files/Sustainable%20Design%20%26%20Construction%20SPG.pdf

**The London Plan, Spatial Development Strategy for Greater London, Consolidated with Alterations since 2011 Greater London Authority (March 2015)**

- http://www.london.gov.uk/sites/default/files/London%20Plan%20March%202015%20(FALP).pdf

**DEFRA Future Water: The Government's water strategy for England (June 2011)**

- https://www.gov.uk/government/publications/future-water-the-government-s-water-strategy-for-england

Policies and commitments relating to water usage are detailed below. The policies relate to all water resources with particular focus on the demands for potable water.

### 3.1.2 The European Union Water Framework Directive

On the 23rd October 2000 the European Parliament and Council established a Community framework for water protection and management. The Framework Directive provides, amongst other things, for the identification of European waters and their characteristics, on the basis of individual river basin districts, and the adoption of management plans and programmes of measures appropriate for each body of water. Within the directive it sets clear deadlines by which Member States should meet certain goals regarding protecting, enhancing and restoring the European water bodies. One of the innovations of the Directive is that it provides a framework for integrated management of groundwater and surface water for the first time at European level.

### 3.1.3 The Water Act 2014

The Water Act 2014 places increased focus on water conservation with the majority of emphasis placed on water companies and premises of public bodies rather than private developers.


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### 3.1.4 The Mayor's Water Strategy, October 2011

The Mayor's Water Strategy sets out a 'six-point plan' of integrated actions to help reduce water demand and cost. The key strategy of relevance is '*to ensure all new development is super-water efficient*' with reference to the London Plan's standard of 105l/p/d. The Mayor also recommends using rainwater for non-potable uses to reduce demand for treated mains water and encourages greater use of water metering.

### 3.1.5 Supplementary Planning Guidance on Sustainable Design and Construction

The Supplementary Planning Guidance on Sustainable Design and Construction identifies key priority and best practice targets on water demand and consumption:

The Mayor's Priority standards are:

- Developers should maximise the opportunities for water saving measures and appliances in all developments, including the reuse and using alternative sources of water
- Developers should design residential schemes to meet a water consumption of 105 litres or less /person/day
- New non-residential developments should aim to achieve the maximum number of water credits in a BREEAM assessment or the 'best practice' level of the AECB water standards
- All developments should be designed to incorporate rainwater harvesting

The Mayor's Best Practice standard is:

- All residential units should be metered

### DEFRA Future Water 2011

In the Future Water the Government's water strategy for England published in June 2011 the paper proposes that the average domestic water use in England should be reduced to 130l/person/day by 2030, with an aim of 120l/person/day, without impacting quality of life.

**The London Plan, March 2015**

The London Plan was originally produced in February 2004 and was most recently revised in March 2015.. One of the major changes relates to lower water demand targets.

Development should minimise the use of mains water by:

1. Incorporating water saving measures and equipment
2. Designing residential development so that mains water consumption would meet a target of 105 litres or less per head per day

### 3.1.6 Targets and Standards

The targets outlined above will be monitored and reviewed as the design progresses and are summarised in Table 3—1.


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**Table 3—1 Potable water consumption targets for residential properties by 2013**

| Body | Lowest standard (L/person/day) | Medium standard (L/person/day) | Optimum standard (L/person/day) |
|---|---|---|---|
| Mayor's Water Strategy | - | 105 | |
| London Plan (Mar 2015) | 105 | - | - |
| Mayor's SPG | 105 | | |
| DEFRA Water Strategy 2008 | - | 130 | 120 |

It is important to note that there are clear targets for residential developments but no current targets for commercial properties. This doesn't mean that demand reduction isn't important here but that the water use targets for these developments are based on an individual assessment of what reductions can reasonably be achieved. Within this report the rate of 105 l/person/day as sought by the London Plan is the target for the residential areas and a similar percentage reduction is sought for the rest of the development where possible.

Section 4 outlines the baseline demand of the development and Section 5 discusses levels of compliance with these policies in terms of demand reduction and matching quality of supply to quality of use, in other words using non potable water with in the development.

## 3.2 Water Supply

Specific policy relating to the approach to water supply are contained within the Mayor's Draft Water Strategy (March 2007) and The London Plan (March 2015).

**The London Plan, March 2015**

Policy 5.15 of the London Plan relates to water supply and resources and states:

> "The Mayor will work in partnership with appropriate agencies within London and adjoining local planning authorities to protect and conserve water supplies in order to secure London's needs in a sustainable manner by supporting the Water Strategy and by:
>
> - Minimising the use of treated water
> - Reaching cost effective minimum leakage levels
> - Maximising rainwater harvesting opportunities
> - Introducing targets for water recycling in major developments
> - Promoting the use of dual potable and grey water recycling systems
> - In conjunction with demand side measures, promoting the provision of additional sustainable water resources in a timely and efficient manner, to reduce the water supply deficit and achieve a security of supply in London
> - Maintaining and upgrading the infrastructure


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> In determining planning applications, the Mayor will and boroughs should have proper regard to the impact of those proposals on water demand and existing capacity"

**The Mayor's Water Strategy, October 2011**

Chapter 2 and 3 of the Mayor's Water Strategy discusses water supply in London and proposes several Actions for water companies to manage their water supplies in London:

- Monitor water usage in new homes
- Raise awareness of water metering
- Increase use of rainwater for potable uses

## 3.3 Drainage & Flooding

The guidelines for surface water drainage and flooding are given by the National Planning Policy Framework document produced by the Department for Communities and Local Government.

**National Planning Policy Framework (NPPF), March 2012**

The NPPF provides guidance for safeguarding developments for current and future flood risk. The NPPF highlights the need for incorporating the issues of flood risk into all stages of the planning process to avoid inappropriate development in areas at risk of flooding. It also promotes using opportunities offered by new developments to reduce the causes and impact of flooding.

**The London Plan, March 2015**

Policy 5.12 of the London Plan relates to Flood risk management and states:

> Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF and the associated technical Guidance on flood risk over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 and Catchment Flood Management Plans.
>
> In line with the NPPFF and the Technical Guidance, boroughs should, when preparing LDFs, utilise Strategic Flood Risk Assessments to identify areas where particular flood risk issues exist and develop actions and policy approaches aimed at reducing these risks, particularly through redevelopment of sites at risk of flooding and identifying specific opportunities for flood risk management measures.

Policy 5.13 of the London Plan relates to sustainable drainage and states:

> Development should utilised SUDS unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:
>
> - Store rainwater for later use
> - Use infiltration techniques, such as porous surfaces in non-clay areas
> - Attenuate rainwater in ponds or open water features for gradual release to a watercourse
> - Attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse



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- Discharge rainwater direct to a watercourse
- Discharge rainwater to a surface water drain
- Discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objections of the London Plan, including water use efficiency, quality, biodiversity, amenity and recreation.

**The Mayor's Water Strategy, October 2011**

Chapter 5 of the Mayor's Draft Water Strategy discusses water supply in London and proposes the following hierarchy (3) for rainwater drainage in London:

- Store rainwater for use later,
- Use infiltration techniques, such as porous surfaces in non-clay areas,
- Attenuate rainwater in ponds or open water features for gradual release to a watercourse,
- Attenuate rainwater in tanks or sealed water features for gradual release to a watercourse,
- Discharge rainwater direct to a watercourse,
- Discharge rainwater to a surface water drain,
- Discharge rainwater to the combined sewer, as a last resort.

Also included is a hierarchy (4) for the disposal of wastewater in London:

- Discharge wastewater to a foul sewer
- Discharge wastewater to the combined sewer, as a last resort.

**The Supplementary Planning Guidance on Sustainable Design and Construction, April 2014**

The Supplementary Planning Guidance on Sustainable Design and Construction identifies key priority targets on surface water flooding and sustainable drainage:

The Mayor's Priorities are:

- Developers should maximise all opportunities to achieve greenfield runoff rates in their developments
- When designing their schemes, developers should follow the drainage hierarchy set out in the London Plan policy 5.13
- Developers should design Sustainable Drainage Systems (SUDS) into their schemes that incorporate attenuation for surface water runoff as well as habitat, water quality and amenity benefits
- Development in areas at risk of any form of flooding should include flood resistance and resilience measures in line with industry best practice
- Developments are designed to be flexible and capable of being adapted to and mitigating the potential increase in flood risk as a result of climate change


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- Where development is permitted in a flood risk zone, appropriate residual risk management measures are to be incorporated into the design to ensure resilience and the safety of occupiers
- All sources of flooding need to considered when designing and constructing developments


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# 4 Water Demand

## 4.1 Baseline Demand

### 4.1.1 Introduction

The baseline is the assessment of the total requirement for water, for all purposes potable and non-potable, of the proposed development. It represents the performance level against which the demand reduction measures and strategy to further minimise the use of potable water can be compared to. It is usually established based on industry standards but can also be based on historic data. This strategy will use a combination of the two and will use previous experience of work on large scale stadiums to provide the benchmarks and targets for water demands.

It is important to note that the targets listed in Section 3 are not to be taken as the baseline demand. These are the targets that need to be met once reduction measures and other non-potable water sources have been identified. There are two baselines that can be explored.

1. The first is the average peak day demand baseline; which is the average water demand on a day when the various parts of the development are at maximum capacity, this helps to inform the supply and distribution infrastructure requirements. The biggest, single influence on this will be that of the stadium demand, due to the infrequent but intense use.

2. The second is the annual baseline demand; this is used to demonstrate the overall water use of the development and provides an alternative indication of where water savings can be made.

### 4.1.2 Average Peak Day Demand Baseline

In order to calculate the average match day demand, water usage measurements were taken at the Arsenal Emirates Stadium, a similar size to the proposed NDP stadium, by the project team. This reading, along with the known fittings in the stadium, has been used to calibrate the usage data and a baseline demand using standard UK fittings is then calculated. The sample stadium data is not used as the baseline as this stadium already had various water efficient fittings installed.

Thames Water have undertaken a network analysis of their infrastructure and confirmed the 10l/s required for the Stadium and Tottenham Experience can be serviced from a new connection off the High Road.

The stadium has been separated down into three categories of users; Spectators, Staff and Players, due to their varying usage types. Assumptions have been made on the number of staff and Players based on prior knowledge of stadia.

The residential properties were broken down into apartment types from which the occupancy was then determined.

The development Masterplan and approximate gross floor areas produced by the architects Populous and A&M have been used to generate the average demand for each type of building within the development based on a water use per person. The demands are based on either the number of users or staff numbers.

The assumptions for occupancy and water demand for each building use is given in Table 4—1.


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**Table 4—1 Occupancy and baseline demand assumptions**

| Development | | Occupancy | Potable water demand (L/person/day) |
|---|---|---|---|
| Stadium (matchday) | Spectators | 61,000 capacity | 4.5 |
| | Competitors | 40 people | 60 |
| | Staff | 1000 people | 25 |
| *Stadium Non Matchday* | | *500* | *25* |
| Tottenham Experience | | (4900 $m^2$) 19 $m^2$/member of staff | 120[1] |
| NE Podium Building ( Office) | | (2000 $m^2$) 10 $m^2$/member of staff | 25 |
| Hotel | | 180 bedrooms plus 49 Serviced apartments | 150 (/bedroom) |
| Extreme Sports | | (2900 $m^2$) 19 $m^2$/member of staff | 25 |
| Residential (4 towers) | | 579 apts. | 150[2] |

The accepted Annual Average Daily Demand for domestic use is 150l/person/day, this is agreed by DEFRA, the Mayor's Office, Thames Water and others.

The Tottenham experience/Museum, Hotel and Office demands are taken from industry standards. Within the stadium there is also a certain amount of water demand from the hospitality and staffing on match days which has been accounted for within the calculations. However, the spectators make up the majority of the demand.

There is a row dedicated to the stadium in non matchday scenario as that is the case more than 90% of the year. The potable water demand takes account of the mix of Club and General admission spectators and is based on POE figures from WHL and Emirates.

These assumptions together with the area schedule have been used to calculate the baseline annual average daily potable water demand for the development as outlined in Table 4—3. The additional water demand from the development that is not covered by Table 4—2 will be for the irrigation of the football pitch. Based on FIFA guidelines for the layout of irrigation of football pitches the demand will be based on a 4 hour irrigation cycle with two sprinklers on at one time. Assuming that 1 cycle will be required during the summer the peak daily demand has been estimated as 50$m^3$/day.

The EA retains the power under Section 57 of the Water Resources Act 1991 to temporarily restrict licences for spray irrigation at times of drought and during periods when restrictions on public water supply are in force. Therefore the irrigation supply could be at risk during periods of drought.

[1] This water demand takes into consideration both the staff and customer water demand
[2] OFWAT Security of Supply Report 2006/7


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**Table 4—2 Average peak day potable water demand**

| Development | | Built area ($m^2$) | Occupancy ($m^2$/person) | Number of people | Potable water demand (L/person/d) | Total demand (L/day) |
|---|---|---|---|---|---|---|
| Stadium | Spectators | - | - | 61,000 | 4.5 | 274,500 |
| | Competitors | - | - | 40 | 60 | 2,400 |
| | Staff | - | - | 1000 | 25 | 25,000 |
| Pitch | | - | 50,000ltr for 200 days from HST. | - | - | 50,000 |
| Tottenham Experience/Museum | | 4900 | 19 $m^2$/member of staff | 258 | 25 | 6,450 |
| NE Podium Building | | 2000 | 10 $m^2$/member of staff | 200 | 25 | 5,000 |
| Hotel | | - | 180 bedrooms plus 49 Serviced apartments | 458 | 105 | *48,090 |
| Extreme Sports | | 2900 | 19 $m^2$/member of staff. Plus public. | *500 | 25 | *12,500 |
| Residential | | - | 579 apartments | 1158 | 105 | *121,590 |
| | | | | | Total | 545,530 |

Table 4—2 represents the baseline for demand reduction to be measured against. It is important to note that this is a daily average based on full occupancy (peak) and does not represent the annual water consumption.


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### 4.1.3 Annual Baseline

The annual average daily potable water demand for full occupancy is skewed by the stadium, which will only be in use 30 – 40 days a year. It is therefore the annual baseline that provides the benchmark for the overall water demand. It is also a better indicator of the applicability of non-potable water sources to meet some of the demand, as for example the stadium will produce large quantities of grey water but it may not be able to be used due to storage requirements. It should be noted, however, that in terms of annual demands the residential demand may be the largest factor of influence. Non-potable sources are discussed in more detail in Section 5. Table 4—3 shows the assumptions made to generate this annual demand.

The annual average daily potable water demands are taken from Table 4—2 and an estimate of the days of occupancy is made. It is assumed that when in use the separate developments will be at full occupancy and at average peak day demand. The assumptions for the irrigation demand of the pitch are different and these and the other assumptions for the frequency of occupancy are detailed below:

- The stadium will be in use for an average of 40 days every year, split as below
    - 19 league games
    - 6 domestic cup games
    - 5 European games
    - 5 friendlies; and
    - concerts
- The residential properties and hotel will be occupied every day of the year.
- The Tottenham Experience/Museum, NE Podium Building and Extreme Sports will be occupied every day of the year.
- The football pitch will have an average of 1 full irrigation cycle 200 days of the year.

Other uses of the stadium, such as for conferences, have not been included in this initial assessment; and the irrigation of other areas of the development has also not been included.

**Table 4—3 Baseline annual water demand**

| Development | Average Daily Demand | Occupancy (days/year) | Total demand (L/year) |
|---|---|---|---|
| Stadium | 301900 | 40 | 12,076,000 |
| Stadium non matchday | 12500 | 325 | 4,062,5000 |
| Pitch | 50000 | 200 | 10,000,000 |
| Tottenham Experience/Museum | 6,450 | 350 | 2,257,500 |
| NE Podium Building | 5,000 | 365 | 1,825,000 |


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| | | | |
|---|---|---|---|
| Hotel | *48,090 | 365 | 17,552,850 |
| Extreme Sports | *12,500 | 350 | 312,500 |
| Residential | *121,590 | 365 | 44,380,350 |
| | | **Total** | **92.4 Ml/year** |

Table 4—3 demonstrates that, despite the large peak daily demand of the stadium, it is the residential development and irrigation demands that represent the greatest demands over the course of a year.


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# 5 Meeting demand

## 5.1 Introduction

This section describes how the water demands of the development may be met.

Many uses of water, such as toilet flushing, clothes washing, etc, do not require a potable standard of water quality, yet these demands are often met from high quality mains water. Treating water to a potable standard and then disposing of waste water are energy-intensive and expensive processes. In addition, the distribution infrastructure is largely dependent on mechanised pumping, thereby adding to the overall energy consumption of the water supply system. Reducing water consumption and utilising local non-potable sources where they are deemed fit for purpose can significantly reduce strain on natural water resources as well as reducing energy consumption.

The easiest and most efficient to implement is demand reduction through social initiatives, then engineering reductions and using non potable sources where appropriate is the final option to achieve the potable demand reduction targets. This section assesses the options available to the development in relation to the reducing of potable water demand.

The strategy will be two fold;

1. Minimise demand by Demand Reduction Measures (DRM); and then
2. Match quality of supply with quality of demand

## 5.2 Demand Reduction Measures

### 5.2.1 Introduction

Demand reduction is a very important aspect of any development. As outlined in Section 4 water resources are under stress and any new development must demonstrate that it uses water efficiently. There are two broad types of demand reduction measures;

1. Social
2. Engineered

The social and the engineered measures are discussed below. Engineered demand reduction takes two forms, efficient fittings and efficient infrastructure. The former can be quantified, as the water consumption of different fittings is known, but it is not possible to quantify efficient delivery systems or social reductions.

### 5.2.2 Demand Reduction - Social

Social measures are the simplest to implement and are very important to change the attitudes to general water use of both individuals and companies. In order to achieve the demand reductions associated with any engineered solutions to reducing water use, education is required to ensure people fully utilise, operate and maintain the engineered solutions adequately.


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Tottenham Hotspur will align itself with the GLA and Thames Water "Save It" water awareness campaign thereby ensuring additional educational messages such as only flushing when necessary, taking shorter showers and turning the tap off while brushing teeth are promoted across the site and will further contribute to reducing overall water demand.

### 5.2.3 Demand Reduction - Engineered

Engineered demand reduction takes two forms;

1. Efficient fittings; and
2. Efficient infrastructure

**Efficient Fittings**

To reduce the baseline potable demand a range of water efficient fittings have been explored for the development and include:

- Water efficient dual flush toilets (4/2.6 l/flush)
- Waterless urinals
- Low flow showers (9l/min)
- Very low flow showers (6l/min)
- Low flow taps (5l/min)
- Very low flow taps (3.2l/min)
- low water usage appliances
- low volume baths

It is assumed that low/very low flow fittings will be installed throughout the development and if standard use fittings are required for different applications, such as the stadium showers, they can be done so on an individual basis.

**Efficient Infrastructure**

The key to efficient use of water is good management. Monitoring of the water networks will enable any leaks to be quickly detected and shut off, minimising wastage of treated water. Metering of properties will clearly illustrate the water use identifying where better water use practices need to be implemented.

In addition to the low flow systems listed above the irrigation of the pitch and other landscaped areas would need to be managed to ensure efficient use. This could be done manually or by using automated systems to irrigate only when required. The pitch will have a very efficient drainage system to avoid waterlogged pitches and with recovery of the irrigation water and rainfall, water could be reused rather than discharged to the foul sewers.

These proposed efficiency measures demonstrate a commitment to the Mayor's Draft Water Strategy, hierarchy 2, by promoting water efficiency fixture and fittings throughout the park. To further reduce the volume of potable water used these measures could be supplemented by non-potable source(s) of water such as rainwater harvesting and other alternatives described below.


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## 5.3 Matching Quality of Supply to Quality of Need

The use of non-potable water depends on the quality of water that is required. This varies for the different uses with differing chemical and biological standards. Where expected end-use results in a high potential for contact with humans the quality of water should be high. Where there is low risk of human contact the non- potable water can be of a lower quality. Additionally commercial uses where water contamination can lead to fouling of appliances will require a high quality potable or non-potable water supply. Further information on water quality standards is given in Appendix A.

Currently there are no published parameters for non-potable water quality but guidelines are listed in Table A1 in Appendix A.

The options for supplementing the potable water supply with non-potable sources, appropriate to that need, include the following options;

- Potable water
- Rain water
- Ground water
- Greywater
- Black water

Recommendations for the supply strategy to be adopted for the development are then discussed in Section 6.

### 5.3.1 Potable water

Potable water is the mains water that is treated to drinking water, Class A standard new connections will be run off the new/existing main as appropriate to serve the developments.

To maximise the efficiency of the potable network the new pipework should avoid losses of water through leakage within the development. Choice of materials for pipework will give due consideration to ground conditions including potential contamination to ensure the pipe network continues to operate efficiently in the long term. Monitoring within buildings is recommended as part of the demand reduction strategy and it is also recommended that meters are placed at strategic points within the main distribution network.

The mains supply strategy provides a robust and reliable source of potable water to the site. It is consistent with the Mayor's water supply hierarchy as the strategy aims to reduce leakage losses and relies on a primary potable water source with existing capacity. Alternative water sources and water recycling opportunities will be fully exploited where cost effective and sustainable to do so.

### 5.3.2 Rain water

Rainwater collected from roofs or permeably paved road surfaces can be used for flushing toilets and landscape irrigation with little additional treatment. Indeed rainwater is often preferable to potable water for irrigation purposes and permeable paving provides hydrocarbon and heavy metal filtration prior to collection in the rainwater harvesting tank. Basic filtering of rainwater prior to entering the tank and a tank volume that allows for regular over-flowing is generally sufficient to maintain water quality in the system. All rainwater tanks will however require a mains water back-up supply to accommodate periods of low rainfall.


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The quantities of rainwater available for use depends on the collection area, the collection area surface, filter efficiency and the average rainfall. Any rainwater tanks would however require a mains water back-up supply to accommodate periods of low rainfall, which will need to comply with TWUL Water Regulations to prevent cross-contamination.

The Pitch Specialists were not prepared to use harvested rainwater for pitch irrigation and the use of waterless urinals on all General Admission areas reduced the application of harvested rainwater and it is not included in the Stadium Scheme.

### 5.3.3 Ground water

The desk study carried out by Envirocheck reveals that half the site is located above a minor aquifer and one likely historic well was discovered. The London Catchment Area Management Strategy (CAMS), April 2006, states that new abstraction licenses in the area will be restricted to 0.5ML/day as an annual average, subject to the local assessment being favourable.

The River Lea valley area is however known to be over abstracted and at this stage of planning ground water abstraction is not a favoured option. It is also not recognised as a non-potable source of water by BRE and so therefore would not be considered as such for water requirements.

### 5.3.4 Greywater recycling

Another viable source of non-potable water that could be harnessed is greywater. Greywater is water that does not include any faecal or food matter and is collected from bathroom sinks, showers, baths and washing machines via a dedicated pipe network. The water is treated and can be stored for up to 5 days prior to use, after this time the water must either be re-circulated or discharged to foul sewer. The end-product, sometimes termed “green water”, is delivered via more dedicated pipework and is suitable for toilet flushing, clothes washing and outdoor uses (not irrigation).

Greywater recycling within properties reduces the potable demand of the development reduces the discharge to the foul networks.

However it does require a considerable amount of additional pipework, which can be expensive ad also the installation of treatment facilities, which will require space within the development. Given the lack of available space on the site this is not an option that will be considered within this development.

### 5.3.5 Black water

Black water recycling is similar to greywater recycling with the exception that all used water discharges are collected and treated. The advantage of this system is that it requires no additional collection pipework; black water would be collected via the proposed sewerage network and treated centrally.

Nonetheless black water recycling is a new technology and as such there are risks associated with its use. As well as the risks associated with any system that does not have a proven track record a black water recycling plant from the foul water service provider would require third party approval and there is always a risk that this may not be granted. The land take required for such a plant would also represent a problem in an already congested development therefore black water recycling will not be considered in this development.

### 5.3.6 Water Supply Summary

The approach throughout the Scheme is to utilise water reducing fittings to manage the water consumption.


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# 6 Water demand strategy

## 6.1 Demand reduction targets

Reducing the potable demand across the development is an important aspect of any planning process and this section demonstrates how this can be achieved. There are only clear guidelines for the potable demand targets of residential properties, due to the range of type of commercial properties clearly defined targets do not exist. However it is important to show that demand reduction in any development has been considered and any measures are at least reasonable.

With the updated London Plan requesting that demand from residential properties should not exceed 105l/p/d, as outlined in Section 3, this assessment will use this target as the minimum required for the development. The potential reductions from efficiencies and non-potable water sources are outlined in this section and a demand reduction strategy will be proposed.

To identify the most appropriate reduction measures to be applied and to where all the options below have been considered. Each type of development will have rainwater systems considered individually for viability but social measures, water efficient fittings, metering and infrastructure will be assumed to be done across the whole development.

## 6.2 Incentives

In March 2004 the Government created Water Technology List to provide an incentive for companies to utilise water conservation appliances and practices within their developments. This means that businesses can now offset 100% of the cost and installation of the products on the Water Technology List against their profits. All companies that pay corporation tax and income tax in the UK are eligible for this 100% capital allowance relief. A full list of the products on the Water Technology List can be found at www.eca-water.gov.uk and it is important to note that only these are eligible for relief and that here is no allowance for domestic systems.

This list includes rainwater harvesting technology, water efficient fittings and leakage detection and monitoring equipment.

Reducing the potable water demand of a development will also go some way to improving its BREEAM rating. Whilst there are currently no statutory requirements to meet certain BREEAM ratings, it is likely that in the future the Government will be introducing Council charges based upon the BREEAM ratings a development has achieved. Meaning that the more developments have been designed to reduce the impacts on the environmental, and therefore achieved a higher BREEAM rating, the lower the Council Charges they will be subjected to. This system will be much like the one already in place within the UK for road tax, with the higher polluting vehicles being charged higher rates.

Significant savings could be made by reducing demand with appliances/efficiency measures rather than potentially having to pay high off-site infrastructure reinforcement costs and incur possible delays if demand exceeds the existing network capacity.

## 6.3 Efficiency Demand Reduction

The following assumptions have been made in order to calculate the savings available:


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- Occupancy and breakdowns for the various parts of the development were primarily based upon information within Employment Densities: A Full Guide. English partnerships & the Regional Development Agencies. Arup, 2001.
- Water demand breakdown for residential properties comes from using the BRE Water Use Calculator
- Water demand breakdown for offices comes from BRE IP15/98. Water Conservation. Shoulder et al. BRE, 1998. The retail breakdown is assumed to be similar to that of the offices.
- Water efficient fittings volumes are taken from various industry standards (Market Transformation Programme).

The breakdown of water demand for the Stadium was an Engineering estimate based upon prior knowledge of working on the Emirates Stadium.

**Table 6—1 Water efficient fittings data**

| Fitting | Baseline | Water Efficient | Highly Water Efficient |
|---|---|---|---|
| WCs | 6l/flush | 6l/4l | 4l/2.6l<br>All |
| Urinals | 7.5 l/hr/bowl | 3.5 l/hr/bowl | 0 l/hr/bowl<br>All (not Residential) |
| Taps | 5 l/min | 3.2 l/min<br>All | 1.7 l/min |
| Showers | 14 l/min | 9 l/min<br>Residential, Stadium and Hotel | 6 l/min<br>Offices |
| Baths | 110 l/use | 100 l/use | 80 l/use<br>Residential and Hotel |
| Washing Machine | 49 l/use | 39 l/use<br>Residential, Stadium and Hotel | - |
| Dishwasher | 13 l/use | 10 l/use<br>All | - |

Table 6—1 identifies the type of water efficient fittings that are and will potentially be more readily available in the future. It also identifies where it is proposed to utilise these fittings within the development in order to reduce the water demand of the development.

## 6.4 Non Potable Sources

Calculations and engineering experience has shown that the use of rainwater can help reduce the potable water demand, therefore improving the environmental impacts of the development, whilst also being potentially financially viable options. The adoption of this technology will not be appropriate in every part of the development and the appropriateness for each section is discussed here.


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### 6.4.1 Stadium including Tottenham Experience.

There are no defined water use targets for commercial properties but the installation of efficient fittings across the development does provide significant savings in potable water use.

### 6.4.2 Residential

With the installation of water efficient fittings within the residential properties it is possible to achieve the target 105 l/p/d rate. Given the complex roof structure of the residential buildings rainwater harvesting is not seen as a viable or necessary addition here.

### 6.4.3 Extreme Sports

The exact nature of this facility is yet to be finalised so appropriate water saving measure will be implemented when the design is further developed.

### 6.4.4 NE Podium Building

There are no defined water use targets for commercial properties but the installation of efficient fittings across the development does provide significant savings in potable water use.

## 6.5 Demand Reduction Conclusions

The use of water efficient fittings and efficient management of the water systems across the Northumberland Development Project will ensure significant water savings. Currently there are no legal targets for water use but planning permission will take into account how the development fits within the targets of the London Plan, therefore it is important to meet the 105 l/person/day rate specified for the residential properties to aid in the planning process.

With the essential water efficient fittings for the residential development it is calculated that a saving of 30% is achieved, thus reducing the potable water demand within the residential development to less than 105 l/person/day. The installation of water efficient fittings throughout the rest of the development will also provide a benefit by reducing the overall water demand. In addition to the annual financial savings in water, which are likely to increase due to the rise in costs of water supply, this will have the following additional benefits;

1. The target water demand as stated within the London Plan is achieved within the residential development;
2. The BREEAM rating for the development would be increased meaning that some more onerous environmentally friendly items would not be required elsewhere in the development;
3. It represents an opportunity for Tottenham Hotspur to be the leaders in green technology in the football world and set a precedent for other stadiums to follow;
4. Negates the need to upgrade the existing potable network; and perhaps most importantly
5. It would show the planning authority how serious Tottenham Hotspur is about reducing its impacts to the environment and could favourably impact the planning approvals.


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# 7 Drainage strategy

## 7.1 Objectives

This drainage strategy aims to provide an overarching appraisal of surface and foul water management procedures to provide a range of design principles and a statement of intent, of considered practices that are appropriate in the confines of the site and surrounding area, and current government and non-government policies and legislations. This drainage strategy will act as a precursor to detailed development drainage design. An assessment of the existing management strategy will also be provided.

### 7.1.1 Methodology

The guidelines for surface water drainage and flooding are given by the following documents, as reviewed earlier within Section 3:

- National Planning Policy Framework, March 2012
- London Plan, March 2015
- Mayor's Water Strategy, October 2011
- Supplementary Planning Guidance on Sustainable Design and Construction, April 2014

These identify similar key requirements on developments such as the need to provide separate surface water and foul drainage networks and the overall promotion of SUDS on site.

**Table 7—1 The London Plan specifically identifies the following standards:**

| Essential Standards Mayor's Preferred Standards | Mayor's Preferred Standards |
|---|---|
| Use sustainable drainage systems (SDS) measures, wherever practical.<br><br>Achieve 50% attenuation of the undeveloped site's surface water run off at peak times | Achieve 100% attenuation of the undeveloped site's surface water run off at peak times |

## 7.2 Background

### 7.2.1 Existing Surface Water Runoff Drainage Summary

TWUL have been consulted regarding the sewerage infrastructure located in the vicinity of the development site and asset location plans provided by TWUL show the location of sewerage surrounding the site. Plans indicate the presence of separate surface and foul water drainage networks (Foul drainage is covered later in 7.3.2). The following points provide a summary of the surface water network in close proximity to the site:

- To the northeast of the site a 229mm sewer runs south to north along Worcester Avenue before outfalling to Northumberland Park. The sewer services the properties to the east and west of Worcester Avenue.
- To the north of the site a 335mm sewer directs flows westward along Northumberland Park.


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- To the west of the site a 610mm sewer flows south along High Road conveying flows from upstream catchments (north and east), before discharging to a culverted watercourse.
- The culverted watercourse, the Moselle Culvert, formally the Moselle River or Brook, once tributary a of the River Lea, continues south along High Road before turning east at Scotland Green and ultimately discharging to Pymmes Brook, adjacent to the River Lea in the east (OS 534904, 189932).
- To the south of the site, along Park Lane, a 914mm x 914mm sewer directs surface water collected from the site and the south flowing surface water sewer in Worcester Avenue, to the east and again to the an outfall at Pymmes Brook (OS 535011, 190336).

#### 7.2.1.1 Existing Surface Water Runoff

Based on the area of impermeable surfaces within the development site (8.46ha) the volume of surface water runoff for a 1 year return period storm is estimated as 1030 litres/second. This volume of runoff is based on a 90% runoff coefficient of surfaces in the development site (allowing for some degree of infiltration to the ground and loss through evapotranspiration) and a rainfall intensity of 50mm/hr.

### 7.2.2 Existing Foul Drainage Summary

The site is surrounded by an extensive foul water drainage network. A summary of the foul network is as follows:

- To the north of the site a 305mm foul sewer runs eastward along Northumberland Park.
- To the east of the northern half of the site a 229mm foul sewer runs north along Worcester Avenue, beside Wingate Trading Estate, before joining the sewer running east along Northumberland Park.
- To the east of the existing White Hart Lane Stadium a 229mm foul water sewer runs south towards Park Lane along Worcester Avenue.
- To the South of the existing stadium (Park Lane) a 229mm foul water sewer runs east where it meets the sewer running south down Worcester Avenue. From here the pipe size increases to a 305mm and flows east.
- To the west of the site a 686mm foul water sewer runs south down High Road.
- There is also an existing 305mm foul water sewer which runs westward along Paxton Road, which with the relocation of the stadium is likely to be removed.

### 7.2.3 Existing Ground Conditions

The findings of a Phase 1 Geotechnical assessment, included as part of the BuroHappold Engineering Infrastructure Review report, indicate that the upper layers of the site generally comprise of Made Ground, with Silt formations and Gravels beneath. This is underlined by London clay (approximately 14 – 20m thickness) and borehole logs indicate a sub base of Chalk. Groundwater can be expected in the gravels layers, with a level between 1.5m bgl and 4.2m bgl.

### 7.2.4 Existing Sustainable Drainage Systems

There are very few existing SUDS features across the development site. On visual inspection, the area is primarily surfaced with impermeable surfaces and the use of surface water flow attenuation, quality control and amenity is limited.


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### 7.2.5 Exceedance

The development has been designed so that the capacity of the drainage network is not exceeded more often than it is currently and introduced improvement on the current situation. Any necessary upgrades to the existing networks have been suggested to provide conveyance for storm water up to the 1 in 30 year annual storm event. Measures have been put in place to reduce the probability of the foul network from surcharging, such as identification of areas for possible ponding of water in events exceeding this size of storm for which the network is designed.

## 7.3 Post Development Drainage Strategy

### 7.3.1 Surface Water Drainage Strategy

#### 7.3.1.1 Introduction

Surface water generated onsite as a result of pluvial (rainfall) sources has the potential to cause surface water flooding to not only the site but the surrounding land if an effective management strategy is not incorporated into the design and implemented. The effective disposal of surface water from the development is a material planning consideration in determining proposals for the development and use of land. It is much more effective to manage flooding at and from new development early in the land acquisition and design process (PPS25, Annex F). The following will outline the methods adopted for accommodating surface water onsite and its subsequent discharge from the site.

#### 7.3.1.2 Construction Phase Strategy

During the construction phase the existing site surface water infrastructure will be used to convey surface water flows. Where construction works are proposed, directly or indirectly influencing drainage infrastructure, the management of surface water flows will be subject to Contactor review and should be included as part of the intended construction works method statement.

#### 7.3.1.3 Completed Development SUDS

SUDS are an approach to managing surface water run-off which seeks to mimic natural drainage systems.

Through a sequence of management practices and control structures, SUDS are designed to drain surface water in a more sustainable fashion than some conventional techniques, by controlling rainfall as near to its source as possible, protecting or enhancing the quality of discharge and providing amenity to previously urbanised areas.

**Pollution Prevention (Good Housekeeping)**

In accordance with the EA SUDs treatment train (Figure 7-1) and the approved Document Part H of the Building Regulations (2015) a hierarchy for surface water disposal exists. Under this hierarchy measures are proposed for use in the development of the stadium and surrounding area. The commitment to provide SUDS will improve the quality of the water discharging from the site with an emphasis on source treatment techniques.

The hierarchy (Figure 7-1) was developed to give a rationale for the development of SUDS drainage systems at a variety of scales. It is a hierarchy which may be tailored to suit the size and the complexity of the area being drained. The full hierarchy (with good housekeeping as an essential addition) has principally been adopted for larger developments.


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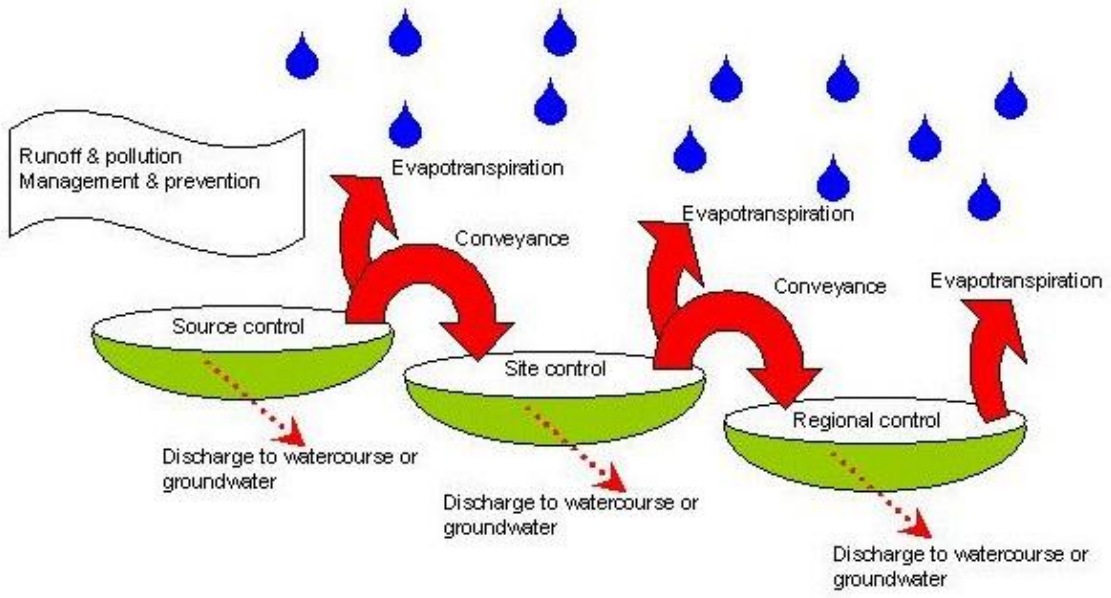


**Figure 7-1 The Treatment Train (http://www.ciria.org.uk/suds/suds_management_train.htm)**

**Design** - Areas considered as potential high risk pollution areas that are integral to the development site have been separated from other drainage areas with treatment appropriate to the potential contaminant or discharge to the foul sewer, where required. Areas include; but are not limited to, car/coach parking areas, service areas (chiefly commercial and stadium delivery areas) and transfer areas.

**Management** – Management and maintenance policies will be developed to ensure that identified surface water pollutants are minimised. This includes programmes for the cleaning and maintenance of roads and gullies and the sweeping of impermeable areas.

**Education** - A programme of educating the public will be undertaken to unsure that the SUDS elements proposed remain sustainable in the long term. This will include informing the public of what chemicals are inappropriate for the surface water drainage system. As an example, the creation of a dedicated surface water drainage network for residential areas will require residents to be informed that it is inappropriate to wash cars with detergents on roads.

### 7.3.1.4 Source Control

Current EA best practise guidance notes that surface water run-off should be controlled as near to its source as possible through a sustainable drainage approach to surface water management. Traditional drainage approaches have involved piping surface water off site as quickly as possible, which has, historically, lead to flooding of downstream catchments. Current sustainable drainage systems look to retain water on site and release it at a controlled rate through a combination of:

- Infiltration into the ground;
- Holding water in storage areas; and
- Slowing down the movement of water.


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The current design for a sustainable surface water drainage scheme limits the peak discharge from the site to 1269 l/s, or 150 l/ha/s, which meets the limit agreed with the Environment Agency and TWUL for the development.

### 7.3.1.5 Site Zoning

For the purposes of surface water drainage design, the site has been split into a number of main areas as described below. Each catchment can be seen in Figure 7-2.

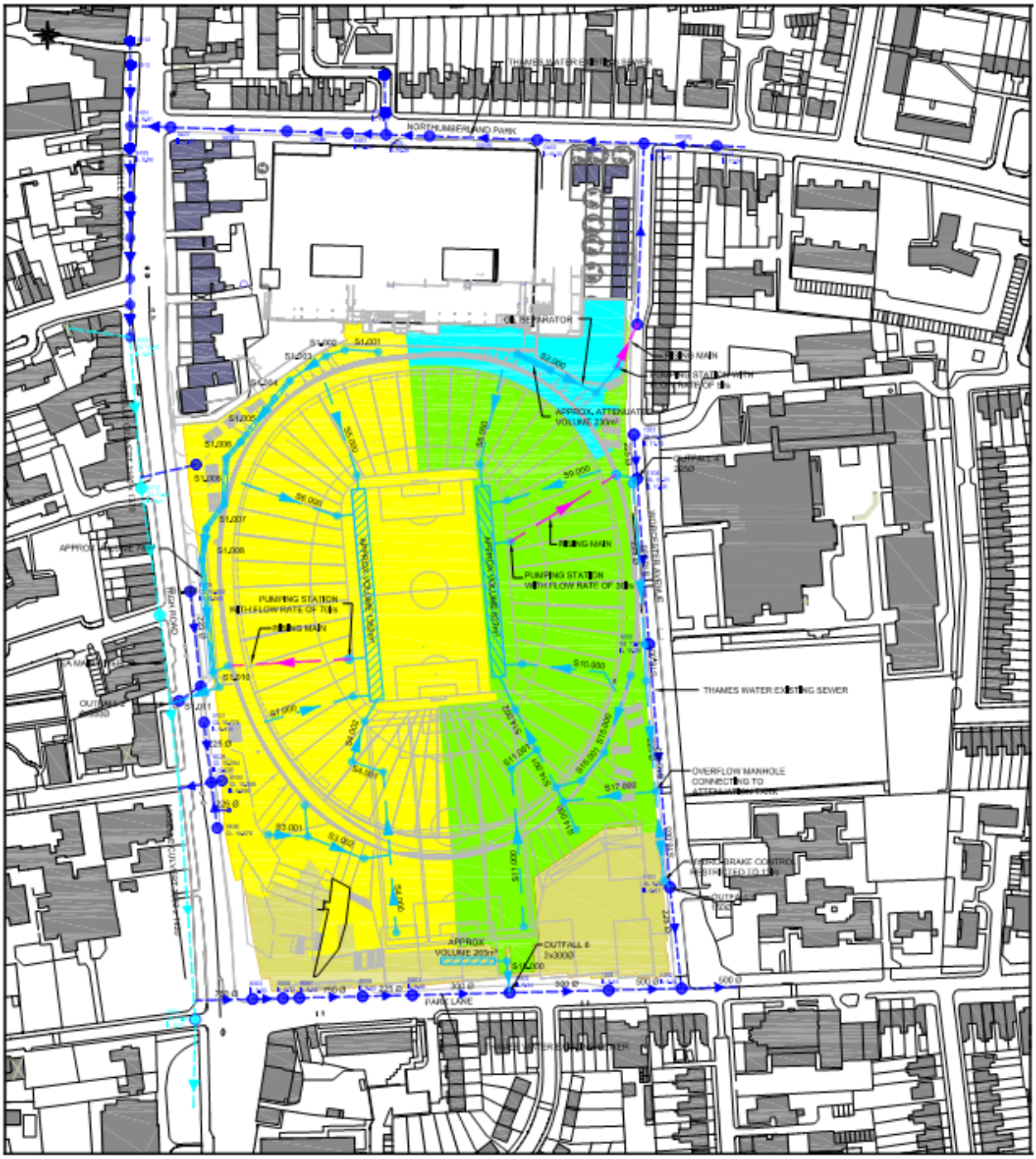


**Figure 7-2 SWD catchment areas**


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**Stadium Zone** – The Stadium site including the public realm and hotel (6.4ha total) will have a surface water network that provides attenuation totalling 1640m$^3$. 1 in 30 year attenuation (980m$^3$) will be provided by below ground tanks. It is anticipated that only a portion of the 1 in 100 attenuation requirement (660m$^3$) will be provided by controlled surface level flooding due to site constraints and the remainder will have to be provided below ground. The Stadium will utilise multiple outfalls due to the size of the catchment, the requirement to use existing connections and the complex phasing sequence. The outfalls will be split between the Moselle Culvert in the High Road (east) and the new sewer to be laid in Worcester Avenue (west). Existing connections will be re-used wherever possible and flow control devices will ensure the total discharge from the catchment is limited to 960l/s. The public realm area will be drained by slot drains which will be connected to the main system. Rainwater harvesting is proposed for part of the stadium roof to reduce the mains demand for non- potable water. The pitch drainage will be designed by the specialist pitch contractor Hewitt's but will link into the wider system.

**South Development** – The South (Residential) development (0.6ha) will have a surface water network that provides attenuation totalling 180m$^3$. At present it is assumed that 100% of the 1 in 100 year attenuation will have to be provided below ground and some pumping will be required due to the basement car park. The system will outfall south to Park Lane re-using existing connections where possible with flow control devices installed to limit discharge to 90l/s.

Hydrocarbon Interception – Permanent parking areas will have pollution control measures including hydrocarbon removal through oil separators.

#### 7.3.1.6 Surface Water Flooding

The surface water drainage system is to be designed to allow for exceedance. In accordance with good practice and to meet adoptable standards the surface water drainage is to be designed to ensure no flooding in a critical duration 30 year storm event. This design criterion used to define the size of surface water storage requirements has been based on 1:100 year storm event plus 20% for Climate Change.

The recommendations of PPS25 for increases in intensity due to climate change have not been accommodated in this assessment as there is no guarantee that the current sewer network would have sufficient capacity to accommodate the increase in flows.

#### 7.3.1.7 Other forms of Flooding

Other forms of flooding identified in Appendix C of PPS25 include reservoir flooding, sewer overflow flooding and ground water flooding. The flood risk assessment has been carried out by Aecom.

### 7.3.2 Foul Water Drainage Strategy

#### 7.3.2.1 Construction Phase

During the construction phase the discharge profile will change as the existing stadium's capacity is temporarily reduced. The existing site infrastructure will be used to convey the foul flows from the site. The sewer running along Paxton Road has been diverted and the surface water and foul water have been pumped further downstream foul network to the High Road.


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Initial TWUL assessment show there to be enough capacity to cope with the proposed development and the resulting increase in discharge, however it is important that when designing the foul water drainage strategy for this development that it will not jeopardise the potential for future development within the immediate area by using up all the available capacity within the system. Therefore the view has been taken that it is important that all new/upgraded drainage infrastructure developed for this proposal will have an allowance for additional capacity to cope with the demands/discharges from any potential developments. TWUL are currently undertaking a capacity study of the local foul network.

#### 7.3.2.2 Completed Development

The development will have a dedicated foul sewer system that is separate from the surface water drainage system, in the same vein as the site currently. The site has been broken down for the three discrete elements of the development as they outfall to different systems. It is important to note that this particular development has an unusual usage pattern, due to it being a football stadium, which leads to a high peak discharge but proportionately low average discharge. Discharge will only reach this peak on match day and even then only for 20 minute periods corresponding to just prior to kick off, half-time and after the final whistle.

The new foul drainage infrastructure will require connection into the existing TWUL network surrounding the site. The Stadium and South Development will outfall to a 686mm diameter sewer on the High Road. Outline approval from Thames Water has been granted on the basis of their being sufficient capacity. The sewers within the site will discharge via pumping stations and rising mains.

### 7.3.3 Pumping Stations

TWUL plans show no pumping stations or rising mains in the immediate vicinity of the site, therefore it is safe to assume that the surrounding network is currently gravity fed.


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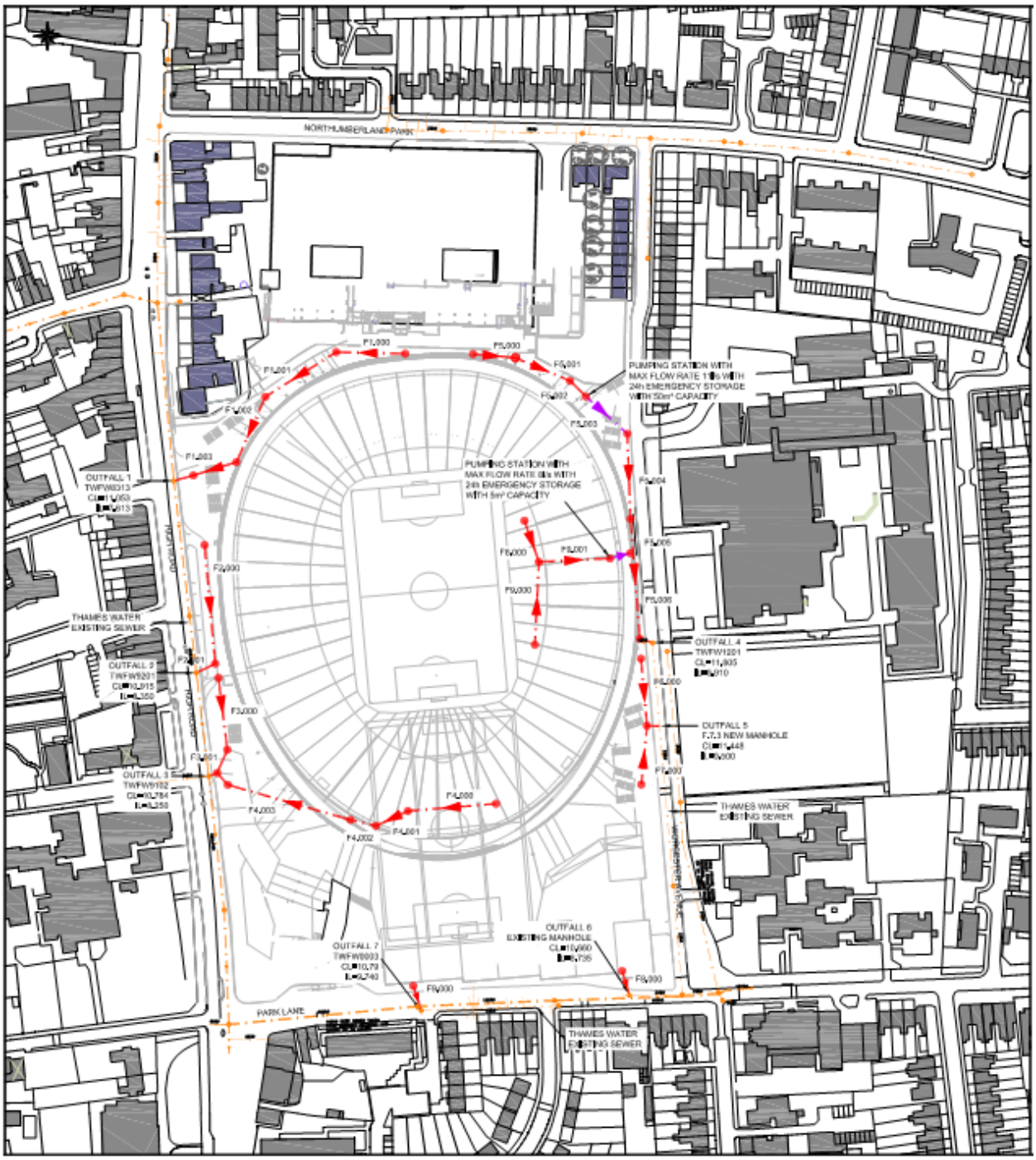


**Figure 7-3 Foul Water Drainage Strategy**


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# 8 Summary & Conclusions

## 8.1 Summary

The Water Strategy identifies the broad strategies in relation to water supply, surface water drainage and foul water. It also introduces the flood risk assessment findings and relates them to the surface water strategy. The central part of this water strategy is however the assessment of demand reduction for the development.

In line with local, national and European guidelines the Northumberland Development Project must be shown to consider and manage all uses and movements of water with the intention of employing efficient systems and practices across the development.

**Potable Water Supply**

It is proposed to connect into the existing water mains to provide the potable water requirements for the development. To minimise any potential upgrade requirements a suite of demand reduction measures are proposed, these will reduce the volume of potable water required for the development and could therefore save money from not undertaking off-site reinforcement works as well as using less mains water. The proposed measures are discussed below.

**Demand Reduction**

The Northumberland Development Project must demonstrate that savings in potable water use have been made in relation to the baseline demand.

It is recommended that water efficient practices and fittings are incorporated across the development. These include monitoring of the water networks and metering of all properties to detect leaks quickly and better inform users of their water use.

Efficient fittings include:

- Low Flush, 4/2.6 l/flush, WCs throughout
- Water Efficient, 3.2 l/min, aerating taps throughout
- Water efficient, 9 l/min, showers within the residential, hotel and stadium developments
- Highly water efficient, 6 l/min, showers within the office, supermarket and megastore/museum developments
- Water efficient, 80 l/use (150 l sized), baths where fitted
- Waterless urinals where fitted
- Water efficient, 39 l/use, washing machine where fitted
- Water efficient, 10 l/use, dishwasher where fitted

With these efficiencies user education will be a key part of water demand reduction as the end users must understand the impacts of their habits as well as knowing how to get the best use from low flow fittings.


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**Drainage**

The site currently drains to separate surface water and foul sewers. The development will maintain the separation and connect into these networks. Local network upgrades will be made on Worcester Avenue with the addition of a new sewer. This is especially relevant to the increased capacity stadium which will have larger peaks in its discharge flows, although the installation of water efficient fittings will minimise this potential increase in discharge volume.

The surface water drainage of the site will aim to improve the existing situation through the introduction of SUDS across the site. This will treat the first flush of a storm event to improve the water quality of the discharge and provide attenuation of storm water to reduce the flood risk to the downstream catchments as well as to the development itself. The site is divided into zones, with underground surface water storage tanks provided for each zone. For the area surrounding the Stadium, permeable paving will be provided so surface water can infiltrate into the underground tanks. The discharge from these tanks will be limited to comply with the 150 l/s/ha limit on drainage rate as agreed with the EA and TWUL. The surface water drainage strategy will be achieved with no pumping throughout the system.

The foul drainage of the development will connect into the existing network and upgrades will be provided to ensure that the systems do not back up and avoid exceeding existing network capacity. The stadium and the Southern Development will drain into the High Road sewer to the west, with the Northern Development draining to the Northumberland Park sewer to the north. The foul water drainage strategy will be achieved with no pumping throughout the system and has been agreed with TWUL.

The potential use of local rainwater harvesting will help to reduce the volumes of discharge as well as reduce the potable demands of the development, potentially avoiding network upgrades. The adoption of green roofs on the residential development will further reduce the run-off and discharge rates.

**Flood Risk**

A separate FRA Document has been prepared by Aecom.

The site is located in EA Flood Zone 1, which means that the probability of fluvial and tidal flooding in any one year is less than or equal to 0.1%. PPS25 requires that developments in Flood Zone 1 do not increase flood risk to the development or elsewhere through the addition of hard surfaces and increase in surface water run- off.

The provision of underground surface water storage will reduce the risk of surface water flooding for the site. A controlled discharge rate from the underground storage tanks will also reduce the risk of the development surcharging the surface water drainage network and impacting on third parties. The controlled discharge is via pumps.

## 8.2 Conclusion

This water strategy shows that the Northumberland Development Project will not adversely impact the surrounding area but will actually improve the current situation in relation to the water infrastructure and the flood risk.

Potable and foul mains will be upgraded if required to serve not only the development itself but the needs of any future developments surrounding the site. Surface water drainage and flood risk will be improved through the use of SUDS, which will retain water and discharge it gradually to the surrounding drainage network reducing the ‘first flush’ impacts downstream.


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The water demands of the development will be reduced when compared to the baseline demand for a development of its size. Efficiency measures will be incorporated across the entire development to reduce the potable water demand in line with the London Plan and wider water saving initiatives. The development will be a leading light in sporting stadia in terms of water efficiency.


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# Appendix A Water quality

Guidelines are presented in CIRIA Guidance C539, Rainwater and greywater use in buildings: Best Practice Guidance, BSRIA Water Reclamation Standard TN 7/2002 and WRAS Guidance, Reclaimed Water Systems.

Parameters contained in the above guidance are given in Table A1;

**Table A1 Guidance for parameters of non-potable water**

| Quality Parameter | Classification from BSRIA Guidance | | | Source |
|---|---|---|---|---|
| | Class A (pressure applications: not to exceed drinking water quality) | Class B (gravity fed applications: may exceed drinking water quality but must take toxicity to plants in to consideration) | Class C (wc flushing: may exceed drinking water quality but must consider the effect on materials water is in contact with) | |
| Total coliforms cfu/100ml | 10 | 1,000 | 1,000 | BSRIA Guidance |
| Faecal coliforms cfu/100ml | - | 10,000 | 10,000 | WRAS Guidance |
| Faecal enterocci cfu/100ml | - | 100 | 100 | WRAS Guidance |
| Total Chlorine ppm | 0.5 | 0.5 | 2.0 | BSRIA Guidance |

Table Notes:

1. The WRAS Guidance sets the faecal coliform level at 10,000cfu/100ml as reclaimed water is not considered to add to the burden of exposure in the toilet environment at lesser levels.
2. The parameters given are in all cases equal to, or more stringent than those identified in the Mayor's Draft Water Strategy.



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